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P01/7700 0.00-0307237.8

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Request for grant of a patent

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1.	Your reference	MNH/ARB/21540
2.	Patent application number *(The Patent Office will fill in this part)*	0307237.8
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	SMITH INTERNATIONAL, INC. 16740 Hardy Street Houston Texas 77205-0068 USA
	Patents ADP number *(if you know it)*	579672001
	If the applicant is a corporate body, give the country/state of its incorporation	A Corporation organised under the laws of Delaware, United States of America
4.	Title of the invention	WELLBORE ANNULUS FLUSHING VALVE
5.	Name of your agent *(if you have one)*	A A THORNTON & CO
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	235 HIGH HOLBORN LONDON WC1V 7LE
	Patents ADP number *(if you know it)*	75001 ✓

		Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	---	---	---

		Number of earlier application	Date of filing *(day / month / year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	---	---

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	7
Claim *(s)*	-
Abstract	-
Drawing *(s)*	2

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	1
Request for preliminary examination and search *(Patents Form 9/77)*	-
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application.

Signature Atkinson & Co. Date 27/03/04

12. Name and daytime telephone number of person to contact in the United Kingdom

ADRIAN BENNETT - 01604 638242

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Notes

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b) *Write your answers in capital letters using black ink or you may type them.*

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WELLBORE ANNULUS FLUSHING VALVE

The invention relates to downhole wellbore apparatus and particularly, but not exclusively, to apparatus for use in wellbore cleaning operations.

It is common practice in the oil and gas drilling industries to periodically clean a wellbore so as to ensure wellbore integrity and maximise the efficiency of oil and gas recovery operations. A technique used in this regard involves pumping a suitable fluid downhole through the annulus formed between the wellbore and downhole equipment located therein. The objective of this operation is to flush unwanted debris down the annulus and back uphole via the interior of the downhole equipment. If considered desirable, the equipment may include a junk catcher in which any unwanted debris flowing uphole within the equipment may be retained. The remaining fluid flow continues to the surface.

A problem can be encountered with the aforementioned cleaning technique in circumstances where it is undesirable for certain materials within the wellbore to be brought to the surface. For example, a wellbore cleaning operation will frequently be conducted in a wellbore which is not considered live (in other words, a wellbore which is not in fluid communication with an oil resource). However, when the precise location of an oil resource is not known for example, it is possible for a wellbore cleaning operation to flush an unexpected mixture of drilling fluid, debris and oil uphole to the surface. This recovery of oil is undesirable and can lead to pollution of the environment.

It is an object of the present invention to improve the downhole tool typically used in wellbore cleaning operations.

The present invention provides a downhole tool comprising a body having a bore extending longitudinally therethrough, wherein the tool further comprises a one-way valve for allowing a flow of fluid in a first direction through the tool bore and preventing

a flow of fluid in a second direction through the tool bore, the second direction being opposite to the first direction; means for rendering the one-way valve inoperable so as to be ineffective at preventing fluid flow; and means for selectively making the one-way valve operable so as to be effective at allowing fluid flow in said first direction and preventing fluid flow in said second direction.

Thus, a string of cleaning equipment including the downhole tool of the present invention can be used in a conventional way whilst the one-way valve is rendered inoperable. However, if undesirable materials (e.g. oil deposits) are recovered at the surface, then the means for selectively making the one-way valve operable may be activated. In this way, the one-way valve will be subsequently capable of allowing a flow of fluid in a first direction through the tool bore whilst preventing a flow of fluid in the second direction through the tool bore. The arrangement of the tool in the string may be such that said first direction is that taken by fluid flowing in a generally downhole direction. Thus, fluid flowing in the opposite direction towards the surface will be resisted. Pollution to the environment may be thereby limited. Furthermore, when the string of equipment is removed from the wellbore, the one-way valve allows fluid to flow downwardly relative to the equipment and drain therefrom.

Preferably, the means for rendering the one-way valve inoperable comprises means for restricting movement of said valve. Said movement restricting means may be movable relative to the tool body and may be biased towards a position wherein movement of the one-way valve is not restricted so as to render said valve inoperable. It is also preferable for said means for selectively making the one-way valve operable to comprise means for releasably retaining said movement restricting means in a position wherein the one-way valve is inoperable. It is particularly desirable for said means for releasably retaining said movement restricting means to comprise a shear pin securing said movement restricting means to the tool body.

The means for selectively making the one-way valve operable may comprise a nozzle which is mounted on said movement restricting means and is movable between a first position, in which a flow of fluid through the body bore is resisted by the nozzle, and a second position, in which a flow of fluid through the body bore is not resisted by the nozzle or is resisted to a lesser extent by the nozzle than when the nozzle is in the first position. The nozzle may also be mounted on said movement restricting means with a

pivotal connection so that the nozzle tends to be moved to the first position by a fluid flowing through the tool bore in said first direction. Preferably, means are provided for retaining the nozzle in the second position when said movement restricting means is in a position wherein movement of the one-way valve is not restricted so as to render said valve inoperable.

Also, the one-way valve may comprise a closure member pivotally mounted to the tool body and movable between a first position, in which fluid within the body bore may flow passed the closure member, and a second position, in which fluid within the body bore is prevented from flowing passed the closure member so that fluid on one side of the closure member is isolated from fluid on an opposite side of the closure member. The closure member may be biased towards the second position.

An embodiment of the present invention will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a cross-sectional side view of an embodiment of the present invention arranged with the one-way valve rendered inoperable;

FIGURES 2 and 3 are cross-sectional side views of the embodiment of Figure 1 wherein means for selectively making the one-way valve operable is being progressively moved so as to make said valve operable; and

FIGURE 4 is a cross-sectional side view of the embodiment of Figure 1 wherein the one-way valve is operable.

The accompanying drawings show a downhole valve 2 which comprises a body 4, a one-way valve assembly 6 mounted within the body 4, and a plurality of further components mounted within the body 4 for rendering the one-way valve assembly 6 inoperable and, as required, selectively making the one-way valve operable. All these components are discussed in greater detail below.

The body 4 comprises standard uphole and downhole crossover members 8,10 for allowing the downhole valve 2 to be connected to additional equipment within a cleaning string. The uphole crossover member 8 is threadedly connected to an uphole body component 12 and sealed therewith by means of an O-ring seal 13. The downhole crossover member 10 is threadedly connected to a downhole body component 14. Both the uphole and downhole body components 12,14 are threadedly connected to one another. A leaking of fluid between the connection of the two body components 12,14 is

prevented by means of an O-ring seal 16 between the two body components. The crossover members 8,10 and the uphole and downhole body components 12,14 have a generally cylindrical shape and, when assembled with one another, define a generally cylindrical body 4 having a bore 18 extending longitudinally therethrough. In use, wellbore fluid flushed through the annulus will flow upwardly through the string to which the valve 2 is connected and, in turn, through the bore 18 of the valve body 4.

The downhole end of the uphole crossover member 8 defines a downwardly facing annulur shoulder 20 which inwardly projects into the body bore 18. An upwardly facing annular shoulder 22 having the same dimensions as the downwardly facing shoulder 20 is defined on the uphole body component 12 in a position downhole of the downwardly facing shoulder 20. A circumferential recess in the body bore 18 is thereby provided in which the one-way valve assembly 6 is located.

The one-way valve assembly 6 comprises two flapper cartridges 24,26 located one above the other. Each flapper cartridge 24,26 comprises a cylindrical body 28 having an outer cylindrical surface in contact with the inner surface of the uphole body component 12 and sealed there against with an O-ring seal 30. Each cartridge body 28 defines an annular valve seat 32 upon which a flap 34 pivotally connected to the cartridge body 28 by means of a hinge 36 may locate. Each flap 34 is biased by means of a spring (not shown) towards a position wherein the flap 34 is engaged with the associated seat 32 so as to seal the body bore 18. The annular surface of each valve seat 32 is downwardly facing and each flap 34 is arranged so as to be movable from the associated valve seat 32 against the spring bias by a fluid flowing downhole through the body bore 18.

When the downhole valve 2 is run in hole, the one-way valve assembly 6 is in an inoperable state. In other words, the flaps 34 are restrained so that they cannot seal against the valve seat 32 and thereby prevent an uphole flow of fluid through the body bore 18. As shown in each of the configurations of Figures 1 to 3, the flaps 34 are retained in a position spaced from the valve seats 32 by means of an elongate cylindrical mandrel 38. When the downhole valve 12 is configured for running in hole (as shown in Figure 1), the mandrel 38 abuts at its uphole end with the downhole end of the uphole crossover member 8 and is retained in this position relative to the body 4 by means of four shear pins 40 mounted to the downhole body component 14. The shear pins 40 retain an annular block 42 in a fixed axial position on the interior surface of the downhole

body component 14. The annular block 42 provides an upwardly facing annular surface upon which the mandrel 38 is supported.

Located between the downhole end of the mandrel 38 and the upwardly facing annular surface of the block 42 is a third flapper cartridge 44. This further flapper cartridge 44 is identical to the flapper cartridges of the one-way valve assembly 6 other than in that the cartridge 44 is located in an inverted orientation (i.e. with the annular valve seat facing uphole) and in that the flap 46 of the further cartridge 44 is provided with a central aperture 48 extending therethrough. By virtue of the aperture 48, it will be understood that the flap 46 operates as a nozzle within the body bore 18. In Figure 1 of the accompanying drawings, the flap 46 is shown biased into engagement with the valve seat. As such, the flap 46 extends across the body bore 18 and provides resistance to fluid flowing downhole through the apparatus 2. However, fluid flowing uphole through the apparatus 2 will displace the flap 46 and pass through the body bore 18 relatively unimpeded.

A spring 50 is located in a spring chamber 52 defined between a downhole portion of the mandrel 38, the downhole end of the uphole body component 12 and an uphole portion of the downhole body component 14. The spring 50 is compressed within the chamber 52 so as to press upwardly on the downhole end of the uphole body component 12 and downwardly on the mandrel 38. The mandrel 38 is thereby biased downhole relative to the body 4. As a consequence, the mandrel 38 presses against the further flapper cartridge 44 which in turns presses against the annular block 42. The spring bias is not however of sufficient magnitude to shear the shear pins 40. As will be explained hereinafter, the shear pins 40 are sheared by selectively increasing the rate of fluid flow downhole through the bore 18 and the aperture 48.

A cylindrical tungsten carbide stinger 54 is secured to, and extends upwardly from, the downhole crossover member 10. The outer diameter of the stinger 54 is less than the inner diameter of the annular block 42, the body of the further flapper cartridge 44 and a lower portion of the mandrel 38 so as to allow these components to move downwardly between the stinger 54 and the downhole body component 14 once the shear pins 40 have been sheared (see Figures 2 to 4). When the apparatus 2 is configured for running in hole (see Figure 1), the uphole end of the stinger 54 is located uphole of the annular block 42 but downhole of the valve seat of the further flapper cartridge 44 so as

to avoid hindering a sealing engagement of the flap 46 with said valve seat. The inner diameters of the stinger 54, the upper portion of the mandrel 38 and the uphole and downhole crossover members 8,10 are approximately the same so as to minimise losses through the apparatus 2.

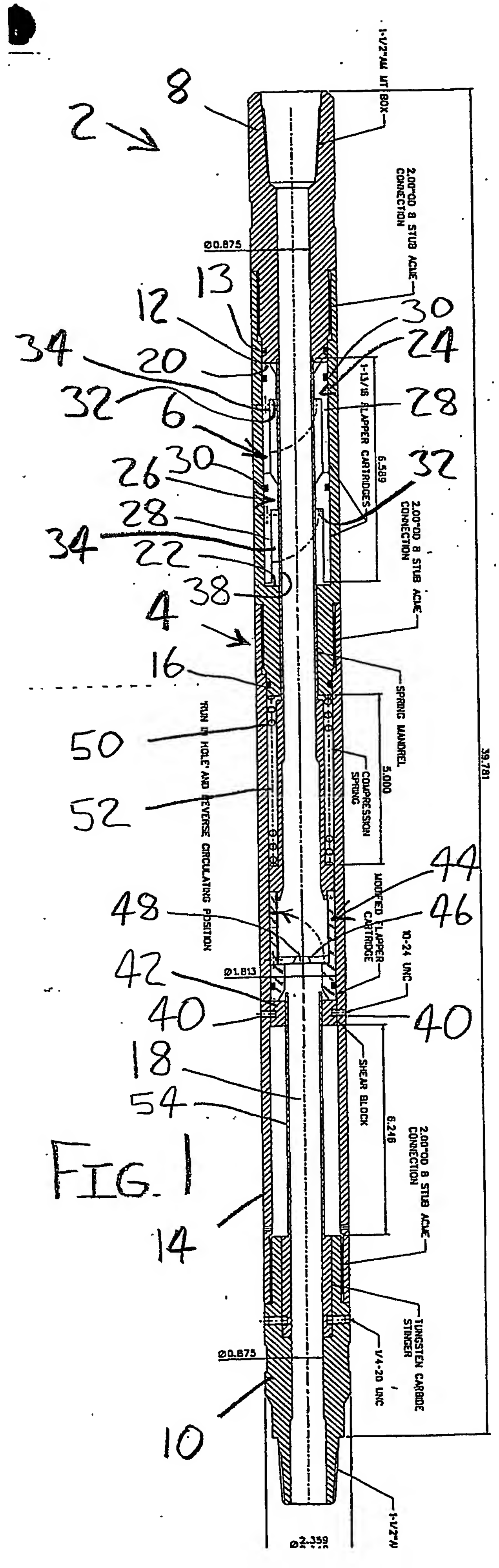
In use, the downhole valve 2 will be typically run downhole as part of a cleaning string. The valve 2 will be run in the configuration shown in Figure 1. In other words, the valve 2 is run with the mandrel 28 located in the uphole position so that the one-way valve assembly 6 is rendered inoperable (i.e. incapable of restricting fluid flow through the apparatus bore 18). The lower flapper cartridge 44 is nevertheless operable and will tend to oppose fluid flowing downhole through the valve 2. As the cleaning string is run in hole, wellbore fluid may drain into the valve 2 from the downhole end thereof and, in so doing, may rotate the flap 46 upwardly against the spring bias associated with said flap. Once the cleaning string is in a required position, the wellbore annulus may be flushed by pumping fluid down the annulus and upwardly via the bore extending longitudinally through the cleaning string. This longitudinal bore includes the bore 18 of the valve 2 and it will be appreciated that the ability of the flap 46 to hinge upwardly ensures this upward flow is not unduly resisted.

If polluting materials such as oil deposits are recovered at the surface, then any further migration of these materials to the surface may be prevented through activation of the one-way valve assembly 6. This activation is achieved by reversing the fluid flow and pumping fluid downwardly through the bore 18. In turn, the flap 46 moves into engagement with its associated valve seat (under the combined influence of the downward fluid flow and associated spring bias). This configuration is shown in Figure 1. The aperture 48 in the flap 46 allows fluid to continue to flow down through the cleaning string, but the flap 46 itself allows the fluid to generate a sufficient downward force of the annular block 42 to shear the shear pins 40 (see Figure 2). Once the shear pins 40 have been sheared, the mandrel 38, flapper cartridge 44 and annular block 42 are pressed downhole by the compression spring 52. As will be seen with reference to Figure 3, as the lower flapper cartridge 44 is pressed over the stinger 54, the upper end of the stinger 54 abuts the flap 46 and rotates said flap 46 against the associated spring bias. With reference to Figure 4, it will be seen that as the mandrel 38 is pressed further downhole relative to the body 4, the flap 46 is rotated through approximately 90° and

locates in the annular space between the stinger 54 and the downhole body component 14. Also, as will be seen from Figure 4, the downhole movement of the mandrel 38 results in the upper end thereof becoming spaced from the flaps 34 of the one-way valve assembly 6 to the extent that said flaps 34 are free to rotate under their associated spring bias through 90° and thereby engage with their associated valve seats 32. In this way, a subsequent migration of fluid (located downhole of the one-way valve assembly 6) upwardly passed said assembly 6 to the surface is prevented. However, fluid may nevertheless be pumped downhole via the bore 18. Such a downhole fluid flow is not obstructed by the lower flapper cartridge 44 since the flap 46 thereof is rendered inoperable by the stinger 54. Wellbore fluid is therefore free to flow downwardly through the apparatus 2 and drain therefrom when the cleaning string is run out of hole.

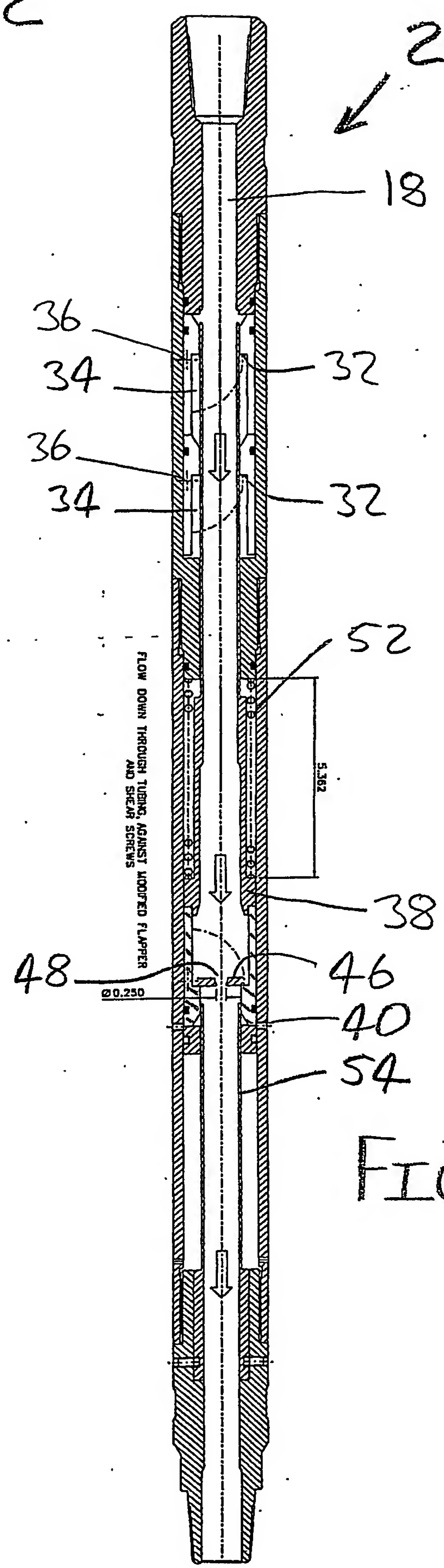
The present invention is not limited to the specific embodiment described above. Modifications and alternative materials will be apparent to a reader skilled in the art. For example, the flap 46 may be provided without the aperture 48 so that the one-way valve assembly may be activated with static fluid pressure.

1/2



2
8
1-1/2"AM MT BOX
2.00"OD 8 STUB ACME CONNECTION
Ø0.875
13
12
30
24
34
20
32
28
6
1-13/16 FLAPPER CARTRIDGES
6.589
26
30
32
2.00"OD 8 STUB ACME CONNECTION
28
34
22
38
4
16
SPRING MANDREL
50
52
COMPRESSION SPRING
5.000
39.781
RUN IN HOLE AND REVERSE CIRCULATING POSITION
44
MODIFIED FLAPPER CARTRIDGE
48
46
10-24 UNC
Ø1.813
42
40
40
SHEAR BLOCK
18
54
6.246
2.00"OD 8 STUB ACME CONNECTION
14
TUNGSTEN CARBIDE STINGER
Ø0.875
1/4-20 UNC
10

FIG. 1



2
18
36
32
34
36
32
34
52
FLOW DOWN THROUGH TUBING, AGAINST MODIFIED FLAPPER AND SHEAR SCREWS
5.362
38
48
46
Ø0.250
40
54

FIG. 2

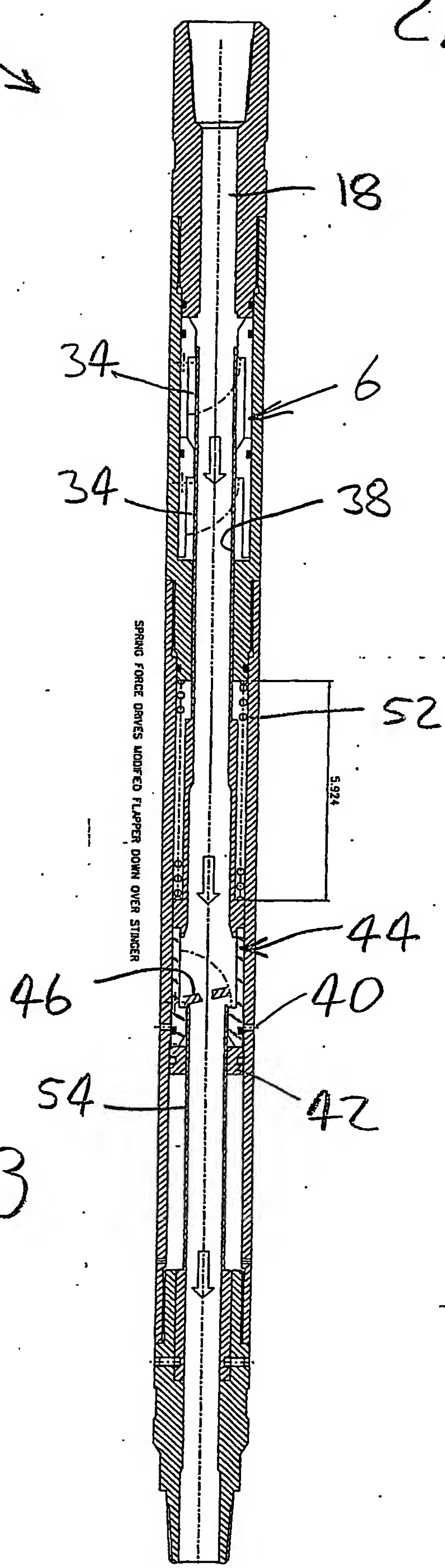

2
18
34
6
34
38
SPRING FORCE DRIVES MODIFIED FLAPPER DOWN OVER STINGER
52
5.924
44
46
40
54
42

FIG. 3

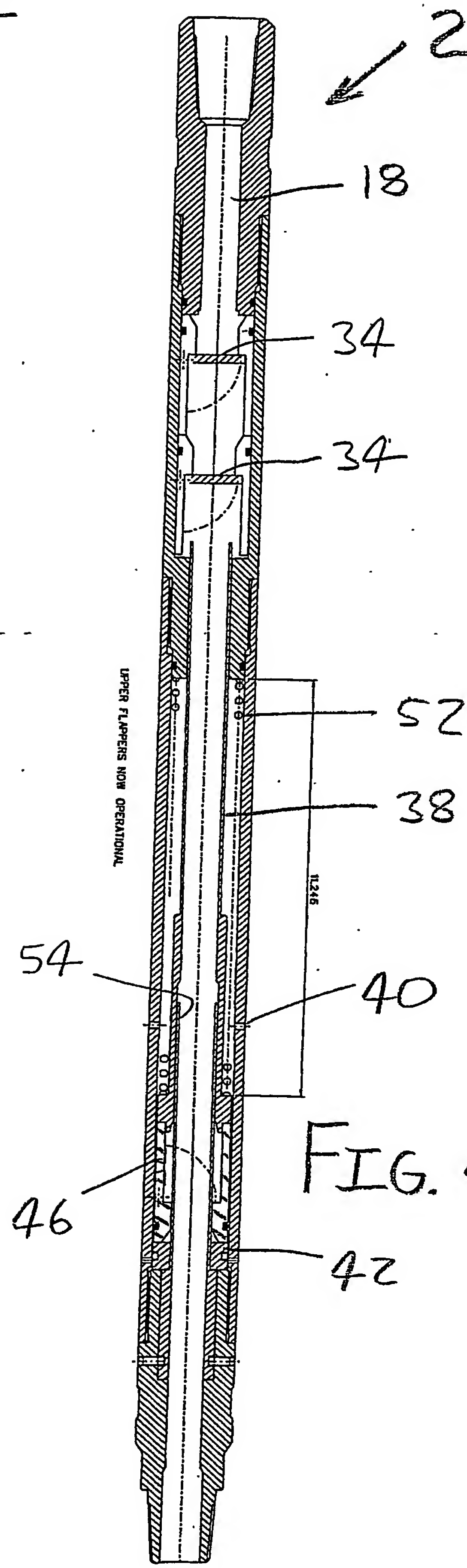

2
18
34
34
UPPER FLAPPERS NOW OPERATIONAL
52
38
11.246
54
40
46
42

FIG. 4

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